LUBRICATION

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THE IMPORTANCE OF GOOD MECHANICAL CONDITIONS FOR LUBRICATION

ONE of the difficulties continually encountered in the attempt to develop economical lubricating conditions is the general lack of any complete understanding of the proper mechanical conditions and equipment necessary for economical and careful lubrication in connection with different classes of work.

While a great deal of improvement has been made in lubricating devices in the past few years, and also all modern power plants and machinery are being constructed with the thought of oil economy in mind, the relation between oil economy and lubricating economy has not always been sufficiently studied and developed to permit the use of these devices in such a way as to bring out their greatest efficiency.

Naturally in coming into contact with plants of all kinds, exhibiting all stages of mechanical efficiency, we have met quite frequently with difficulties in the way of economical lubrication which originate and are entirely due to the lack of proper mechanical arrangement or want of appreciation on the part of those handling lubrication of the importance of certain kinds of oil for certain purposes.

As an instance of this, in some plants, particularly in the summer months, it is the practice to mix cylinder and engine oil for external lubrication, and this is usually done because the engine oil is too light for the work required and cylinder oil is added to give it body.

As a matter of fact, the admixture of cylinder and engine oil, while it is undoubtedly done because of the belief of the engineers that better lubrication can be secured in this way, is never as economical, either from the standpoint of friction reduction or cost of oil as to use a good grade of engine oil suited to external lubrication under the conditions required.

In the same plants the plan fre-

quently obtains of mixing engine oil with kerosene during the winter months where the engine oil becomes thick and difficult to use. The introduction of kerosene, of course, largely destroys the lubricating value of the oil, and the use of a material with the proper body and cold test for the winter conditions would be infinitely better from the standpoint of lubricating economy in cost and frictional losses.

A number of difficulties arise where either individual or general circulating systems are adopted and the oil reused. These difficulties have a very great effect upon the power economy, and suggest that the conditions most suitable for the proper circulation of oil are not by any means secured in many cases.

The presence of cylinder oil in the circulating system is never a good thing, and it is always an advantage to take measures to relieve this condition as far as possible. This feature is now being recognized by some engine manufacturers who are constructing the bottom guide base so that the cylinder oil dripping from the piston rods and stuffing boxes is drawn off separately so that it does not come in connection with the oil in the circulating system.

It was a practice some years ago, and is still the practice in a number of cases, to use water in the filters or settling tanks. The introduction of large turbine and gas-engine units with circulating systems, introduced new problems which create some difficulties where water is used in the settling tanks, which difficulties are partly due to the presence of water in the circulating oil itself.

The original idea in having water in the filters or settling tanks was to float the oil on the body of water, allowing the heavy dirt to precipitate, on the theory that the oil passing through the water will be washed. As far as the settling process is concerned, the use of a constant body of oil instead of the water will effect the same purpose.

As regards the washing effect secured by passing the oil up through the water, it is a matter of controversy as to how far this is effective, but in any case the separation of the dirt and foreign particles from the oil depends largely upon arranging the circulating system so that a sufficient time is allowed for the oil to rest, to enable the settlement of foreign matter that may have been taken up in its passage through the system. This means that the flow of oil should be slow and the volume in the system should be large in comparison with the amount required for the various bearings to be lubricated.

Any water used in the system for settling purposes simply decreases this volume of oil and consequently decreases the time which can be allowed for settlement.

Further, where water is used in the settling system the difference in gravity between the oil and the water is sufficient to allow of rapid passage of the oil through the water; whereas, if this water is replaced by an increased volume of oil, the process of filtration is aided to some extent on account of the fact that the whole body of liquid is of equal gravity, and the passage of incoming dirty oil through the body of oil in the settling tanks is to some extent retarded.

A further trouble in connection with water used for settling in a circulating system lies in the tendency of an oil to increase in body through use. This increase in body makes the separation of the oil and water a little bit more difficult, and unless the proper time is allowed in the system for such separation, the oil and water used in a bearing under pressure and heat have a tendency to form an emulsion which may become sufficiently troublesome to require shutting down the plant.

This difficulty is particularly serious where the circulating systems are too small to take care of the lubricating requirements and consequently the oil is rushed and there is not sufficient time allowed for settlement of dirt and water.

The arrangement, particularly the location and size of the filters and settling tanks in connection with a circulating system, is of the utmost importance. One recent case which came to our notice was a system, in which the equipment was so placed as to make it practically impossible to secure any efficiency therefrom, as can be seen from the following description.

A 1000-gallon receiving tank was located in the basement beneath the engine room, receiving all the oil, dirt, and water returned from the various engines. This mixture was pumped to another 1000-gallon tank on the engine room floor, the pump being connected to the extreme bottom of the receiving tank. On account of the number and size of the engines and consequently the amount of oil required, the whole mixture of oil, water and dirt was pumped from the receiving tank as quickly as it arrived, allowing no settlement or precipitation at this or any other point.

Under these circumstances also, the pump acted as an agitator to thoroughly mix the oil, water and dirt, and further eliminate any possibility of separation.

After being pumped to the 1000-gallon tank on the engine room floor level, the oil passes through two 500-gallon tanks to an "emulsifier" and thence to the filters. From the latter point it is again pumped to the gravity tank. To properly handle the oil, the filter and settling tanks should all be placed in such a position that the oil returned from the units could pass through the filters first. This would remove the small particles of dirt and assist in separating the entrained water. From the filter the oil should pass by gravity to the several settling tanks which should be kept at a regular temperature of at least 150° F., and should then be allowed to rest a sufficient time to permit of the remaining dirt and water precipitating by gravity.

Under these conditions, the 1000-gallon tank in the basement, instead of acting as a rest tank (as was no doubt the intention of the designer) was simply used as a reservoir and renders no assistance whatever in the work of cleaning the oil. It is particularly useless to the system, and the work which is being handled by this tank could be taken care of by a fifty or 100-gallon tank. The pump, at the point at which it is attached to this tank, is not only useless but creates a condition directly contrary to efficiency of filtration. Under no circumstances should any pipe attached to any part of a filtering system be located at the bottom of a tank, but should always be placed in such a manner as to permit any water or foreign matter which is separated from the oil to remain in the bottom of the tank to be drawn off, either by hand or automatically. Designing or operating circulating systems, where these details have been overlooked, will naturally result in the lubricating efficiency being low.

Further showing the effect of improper mechanical conditions; sometime ago we were called upon to investigate the burning out of a bearing in a 50 H.P. electric motor, in which it was claimed that the fault was attributable to the oil. This bearing was equipped with a ring oiler, and upon investigation it was found that the set screw holding the bearing in place had, through the vibration of the engine or some other cause, worked loose and permitted the bearing to turn completely over which caused the ring oiler to become

displaced, and the bearing and shaft to receive no lubrication.

Difficulties which are met with from time to time by our engineers in connection with lubricating problems, some of which have been mentioned above, show that many times the conditions due to mechanical arrangements are to some extent responsible for inefficient lubrication. Our engineers are trained to consider not only the lubricating problems *per se* but also the mechanical problems connected therewith, so that in the natural course these problems will have the proper attention. There is sometimes a tendency to charge all difficulties to the character of the lubricating oil where this is not the case. As a matter of fact, the lubricating efficiency depends just as much upon the mechanical condition as upon the oil, and both must be properly understood and taken into consideration in order to secure the most economical lubrication.

ABSTRACTS FROM "ECONOMIC USE OF LUBRICATING OILS"

By David A. Corey
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With the Permission of the Nat'l Assn. of Cotton Mfgrs.

IN the letter inviting me to present a paper at this meeting on the Economic Use of Oils, the following sentence occurred:

"While it is conceded that this is not adaptable as a whole to much of the cotton textile machinery, yet it is adaptable to repair shops, engine rooms and main shafting, which cost money, even if they do not make cloth or yarn directly."

It is this question of the application and adaptability of economic methods to the use, care and saving of oils in the textile manufacturing plant that I propose to discuss. It is true that the oil question cannot be measured in the familiar terms of the industry, as "picks" and "twists," "warp" and "filling," but it does nevertheless, have a direct bearing upon the manufactured goods through its general effect upon the efficiency and production, and is quite as important and should have as much thoughtful care and consideration as the selection of improved machinery. The harder and more exacting the service required, the higher the standard of manufacturing efficiency, the more the attention which should be given to the subject. This applies, not only to the selection of oils suitable for the various requirements, but quite as much to a proper method of storing, dispensing, and otherwise caring for and conserving the materials purchased.

Oil costs money; it is an important factor in the successful operation of machinery. The lack of oil or failure to properly care for that in use is a serious matter and is, perhaps, more than any other one thing the cause of failure to secure maximum efficiency in machine operations; and that loss costs more money. This applies with equal force to the power house, to the machine shop, to transmission machinery and to the producing machinery. Improved service means more profit, and so from one viewpoint or another, everyone, from engineer and operator, to official and stockholder, is interested in this general subject of efficiency.

The selection of oils for the many requirements of a manufacturing plant is a matter which is worthy of, and is now receiving, much more

study than was the case a few years ago; and the purpose of many expert and practical tests is to determine what lubricants are best for high, medium and low speeds, for light and heavy journal bearings, etc., and it is generally conceded that such tests are the only true means of definitely determining what oils render the best service under different conditions. Reliable oil manufacturers are prepared to submit the results of such tests and, for fixed and definite service, to guarantee results.

In railroad service it is now almost universal practice to contract for the entire oil supply on the basis of specified quantity per car mile: and that quantity is allowed for the operation of each car for each mile or thousand miles traveled. In the same way, premeditated quantities of lubricating and cylinder oils are issued to the engineers for their fixed "runs," all based upon a certain quantity per thousand miles. Of course, to make this possible, the operating equipment must be taken care of and kept to the highest point of efficiency, but that alone is a strong factor in favor of the plan. It is quite possible and I think we may safely say probable, that a similar plan will some day be evolved for issuing oils and supplies in manufacturing establishments having a standard output on the basis of production, and that the plan will be instrumental in effecting greater efficiency and so decreasing production costs.

To make the saving and low costs of oils effective to the highest degree, it is necessary, after the selection of oils has been made, to provide suitable means for properly storing and issuing them. The common plan of keeping oil in barrels is especially wasteful. It has been well said that barrels are for transportation, not for storage purposes. The loss by seepage, evaporation, absorption, non-drainage of barrels, and from faucets would be appalling if realized by the men who pay the bills. Practical tests in manufacturing plants by engineers who are constantly studying this subject show actual losses in lubricating oils of from 5 to 25 per cent. or 2 to 12 gallons per barrel of an average capacity of 50 gallons. In paint oils, such as linseed, turpentine, varnishes, etc., the losses approximate the same, but in gasoline or naphtha and other volatile oils, the loss is much greater. Barrels in storage which had not been opened have been found to be entirely empty.

Among many others, five cases have been observed within the past few months which are of special interest because of their size and the impression created by the figures shown. In each of these plants the methods of purchase, storage and handling are those usually employed; the oils, except naphtha which came in tank cars, being received in barrels, and stored in them, and drawn through faucets as required. Careful study by an efficiency engineer, cooperating with representatives of the concerns interested showed results as shown on the next page.

The large relative differences shown are in a measure due to the differences in values of materials handled, but these estimates are safe and conservative, having been made up after an intimate examination of the conditions prevailing in the five plants, and the figures used were taken from their books. In every case the analysis and statement were endorsed by representatives of the interested parties.

An important phase in oil and manufacturing economy, when the character of machinery renders possible the necessary equipment, is the re-use of oil. To re-use oil it must necessarily have all impurities that will cause damage removed, else the re-use will result in actual loss. In many plants the oil used is caught and

Number of oils and liquids handled	Total number of gallons used per year	Loss by leakage, evaporation and non-drainage, plus estimated saving by improved method of handling and purchase
15	55,150	$2,574
12	79,000	3,340
69	618,696	12,000
32	1,715,520	45,634
50	353,900	56,410

again used on rough work, where the impurities will do no appreciable damage.

It may seem that in such cases the loss has been well guarded against, and that any further saving would be too small to justify an investment or the spending of much time in its consideration; but lubrication economy means vastly more than the first cost, for the lubricant supplied may be entirely used up in service with virtually no waste or "drips," but this is not economical lubrication. Practice has demonstrated that there is always another item of expense besides the oil cost, and that is the cost of repairs or renewals due to injury arising from too scant lubrication, and this practice has coined the expression "sufficient lubrication."

This is a wholly inadequate and misleading term, for as commonly used it means only enough lubrication to prevent injury to the journal. It in no way measures the economy of lubrication but rather defines the limit of loss that is endurable without destroying the journal.

In modern practice the so-called "Sufficient" lubrication is no longer considered adequate; flooded journals are demanded and the highest economy requires the re-use of oil. No half way provision is tenable, and if oil is to be re-used, there is no object whatever in restricting its use. The expression "the more oil you use, the less you lose" is wholly correct. The friction losses are governed to a very large extent by the quantity fed.

The losses due to faulty lubrication are far greater than are generally recognized.

The same care should be exercised in the installation of all new machinery which requires lubricated journals; for friction in the factory affects the coal pile just as much as does friction in the engine room.

Oiling systems and ring oiled bearings have come into use during the life of the present operators and have met with opposition from the start. The first obstacle was the general prejudice against re-using oil; and following this was the reluctance of manufacturers to make up new patterns suitable for the re-use of oil. Bearings for line shafts were first arranged for grease, then for wick or capillary oiling and now the use of ring, chain or collar oiling is quite general throughout the factory. The general tendency in the matter of oiling shafting is correct as all general tendencies are bound to be.

It may occur to the power user that since his machinery has not been equipped for stream fed lubrication,

it would not pay in his case to arrange for such. It is doubtful if there are any such hopeless cases.

If the best practice is not obtainable. at least a far more efficient system may be employed than the existing scant or drop feed oiling, or the re-use of dirty oil. The physical conditions of the plant must determine just how perfect a system can be employed. The bearing shown in cut No. 1 is one especially suited for stream feed and drops drained away, this permitting the highest possible grade of lubrication. The oil runs off the bearing and cannot be re-

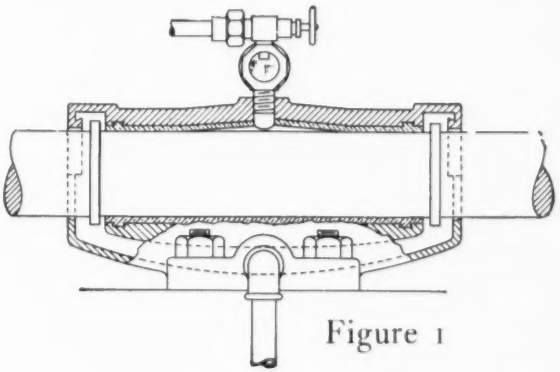


Figure 1

Stream Feed Bearing

turned to it, until it has passed through a filter, and such impurities as would injure the journal removed. The collars on ends of journal prevent the oil creeping along the shaft. This form is as safe against shut down as any system that can be devised.

Another method of increasing the efficiency of ring, collar or chain-oiled bearings is to occasionally wash out the bearings and supply with clean oil. This is more troublesome and not so efficient as the piped system shown in cut No. 1, but it is probably the most efficient arrangement used at present for shafting, motors and the like. The great objection to this method is that so little attention is given to a journal after it has been filled with oil. Possibly once a month a little more oil is poured into the oil receptacle, and nobody ever thinks of cleaning it out. This is the use of dirty oil in its worst form. There is enough oil in the journal to keep it from melting out the Babbitt, and that is about all the good that can be said of it. It produces much friction and causes much wear of the bearings.

By observation and comparison of the power required to drive a line of shafting and the idle running machines, first with clean and then with dirty oil, and knowing the length of time this loss was endured, it can be readily determined whether it pays to change oil every month, or oftener. If the saving in power alone is equal to the labor cost it would be justified as all other savings would be clear gain. But for heavily loaded, troublesome bearings, wherever they may be, some arrangement of flooded lubrication should be provided. If it cannot be connected to a central oiling system, then provide an individual system with possibly a rotary pump run by the machine. The re-use of a large quantity of oil is imperative wherever friction is at all noticeable, and it is safe to assume

that some satisfactory arrangement can be provided. Hot or troublesome bearings are positive indications of careless or indifferent regard to operation economy. The application of grease, graphite and the like may aid, but it cannot eliminate the lubrication loss. Wherever grease is essential for operation look closely for something wrong. Flooded journals will stand virtually any service to be met in ordinary factory service, and to provide flooded journals we must use the same oil over and over again; there is no alternative.

But little has been said in regard to the machines in the factory. If the bearings be small, requiring but little oil, and no provision has been made for flooded lubrication, it is safe generally to assume that the economies to be divided will not justify the expense and complications which would be met, but in securing new equipment an effort should be made to have stream fed or ring-oiled bearings. In many cases the hand oiler must continue, and it must, in fact, be conceded that in textile mills the conditions are such as to make this method necessary, but many special devices for safely storing and handling have been designed as the basis for conserving the oils, to minimize the cost and assure ease and accuracy in handling, to preserve the quality, to keep the oil free from dust and lint and to reduce the fire hazard to the minimum.

The common method of distribution in mills is by means of tanks of 10 to 60 gallons capacity in the different departments, the sizes depending upon the judgment of the management; some preferring few large tanks while others prefer small tanks placed at more frequent intervals. The latter plan is very satisfactory as the small tanks can be removed from the mill for filling at the storage house outside, and in the mill are more conveniently located for the operatives.

When small tanks are used, several of them can be transported on a truck to the storage room and returned in the same manner after filling. A tank of this kind should preferably be equipped with a non-overflow discharge, so that the oil

Figure 2

Dust-proof Oil Tank with Non-overflow Discharge

cups can be quickly filled without spillage and without the usual accompaniment of waste which becomes saturated with oil, is thrown away, and becomes a fire menace.

Another method of distributing to tanks in the mill is by means of portable tanks, which are filled at the storage room, wheeled into the mill and the oil discharged into the permanent tanks by means of pumps.

These methods are decided improvements over the present common one of taking barrels on elevators to

Figure 3

Portable Oil Tank

this system are manifest, especially where large quantities of oil are used in manufacturing operations, and measurements of the quantity delivered is desired. In utilizing any of the plans suggested, to get the full value of the system the amounts issued to each department should be charged against that department, and to this the measuring features of the supply pumps are of great assistance. The neatness of the well-equipped central storage room, showing the elimination of barrels and the use of steel tanks without faucets or any openings in the tanks except in the tops, the oils being drawn by means of oil pumps, and certain oils stored in underground tanks and drawn by means of long distance pumps is shown in the illustration (Fig. 5) of the equipment of one New England mill.

the different floors, rolling them through the mill to the stationary tanks and using transfer pumps or similar methods for transferring the oils from barrels to tanks. Leaky, and sometimes broken barrels leave traces behind, and this custom is dirty and dangerous. Fig. 4 offers a suggestion.

A third method and one which is being largely adopted for certain factory uses and does away with transportation about the plant, is by means of long distance pumps operated by hand or power, located at convenient points about the factory and drawing the oils from one central storage point. The advantages of

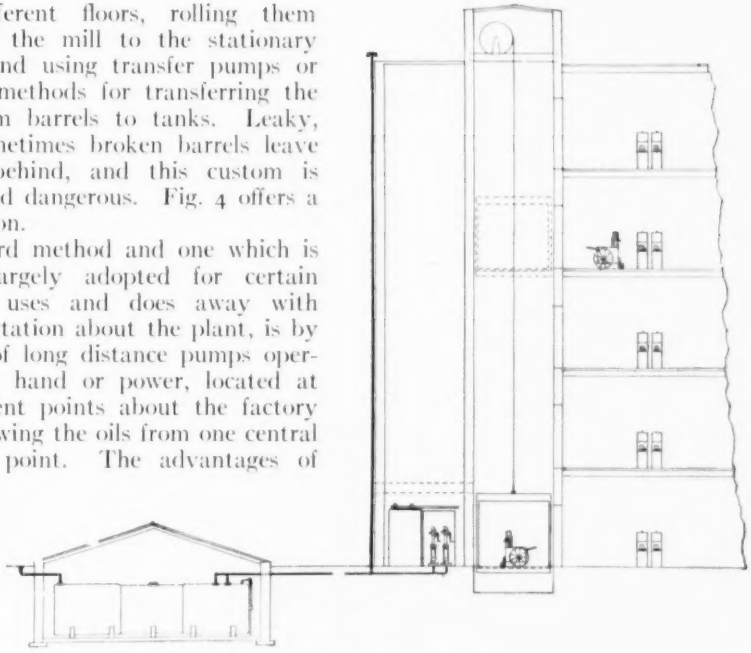
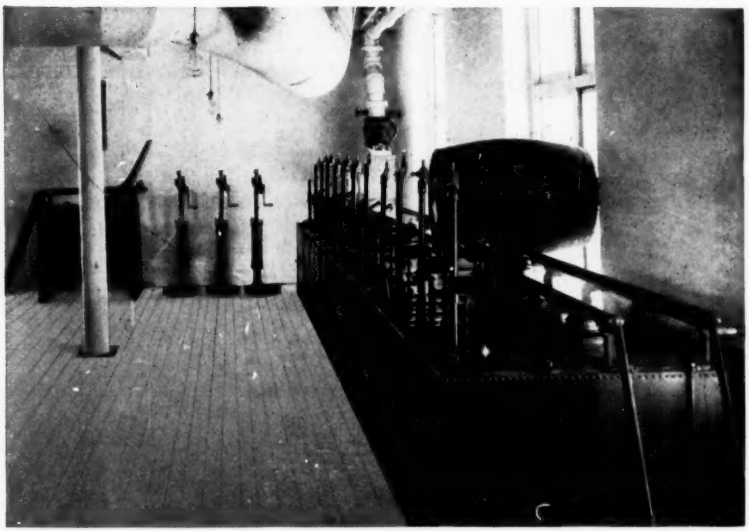


Figure 4

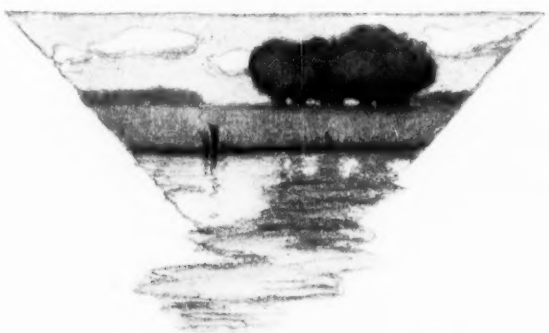
Outline of Factory Oil Equipment



A New England Mill Oil Room

Still another method of delivering and measuring oils and other liquids, is by means of an electric remote control system of pumps and measuring devices, used in manufacturing operations where considerable quantities are required in mixing, compounding, etc. The measures are automatic in delivering any desired or predetermined quantity.

The whole subject of oil handling and lubrication efficiency is now recognized as one of great importance, as is shown by the consideration and study which has brought about the development of special apparatus and the investment of capital in its manufacture to meet the needs and demands. It is a subject large enough to warrant the attention of every manufacturer and the advice of experts, for it is directly and indirectly a considerable factor in the cost of operation and production, and upon efficiency depends dividends.



TEST ON 125 H. P. OTTO GAS ENGINE, BELTED TO A 30-LB. HORIZONTAL YORKE ICE MACHINE

THE engine was run at 180 R.P.M. and operated by producer gas. The same oil was used to lubricate the cylinder of the engine and all of the outside moving parts of the gas engine and ice machine. The oil in use at the time our engineer made the inspection was a rather good grade of competitive oil, and against this a test was made with our Texaco Ursa Oil; an oil of considerably greater viscosity made from an entirely different crude oil base than that used to produce the competitive oil.

A schedule was arranged, so that an accurate amount of competitive oil, covering a given time, would be recorded, and temperatures and all observations would be made in a systematic manner for both oils. The conditions surrounding the engines were observed for seven hours under each set of conditions. The result of the cost and consumption test was as follows:

	Competitive Oil	Texaco Ursa Oil	Reduction due to Texaco Ursa Oil
Cost per gallon	28 cts.	32 cts.	
Total measured consumption . .	15 pts.	5 pts.	10 pts. or 66.6%
Time	7 hours	7 hours	
Cost	0.525 cts.	0.20 cts.	0.325 cts. or 61.94%

This shows that with the higher-priced, heavier bodied Ursa Oil, much less was used, resulting in greatly reducing the total cost of lubrication.

In securing the above figures, the utmost care was taken in measuring the oil and the readings were carefully checked over by employees of the plant. The average readings on engine test were as shown on the following page.

What is to be borne in mind in considering the above figures is that the Texaco Ursa Oil was much heavier, as far as the viscosity is concerned, than the competitive oil, and that the Ursa Oil contains very remarkable lubricating properties in order to allow the bearings and rubbing surfaces to run cooler than when lubricated with a lighter bodied oil. The temperature due to friction was 18° F. with the competitive oil and 14° F. with the Texaco Ursa Oil, which makes a reduction of 4° F. or 22.2% in favor of the heavier Ursa Oil. This is the effect of lubrication of an outside bearing influenced by atmospheric conditions.

The effect of the action of the Texaco Ursa Oil in the cylinder of the gas engine is shown very clearly by the difference in the amount of waste heat that is being taken away from the gas cylinder by the cooling water during both series of tests. This water has the same temperature upon

	Competitive Oil	Texaco Ursa Oil	Reduction due to Texaco Ursa Oil
Room Temperature	92° F.	94° F.	
BEARING TEMPERATURE			
No. 1 Bearing	110° F.	106° F.	
No. 2 Bearing	110° F.	110° F.	
FRICTIONAL HEAT (Temperature of the bearing less the temperature of the room)			
No. 1 Bearing	18° F.	12° F.	6° F.
No. 2 Bearing	18° F.	16° F.	2° F.
Average	18° F.	14° F.	4° F. or 22.2%
COOLING WATER			
Suction	70° F.	70° F.	16° F.
Discharge	110° F.	94° F.	or 14.5%
Increase	40° F.	24° F.	
Pressure	170 lbs.	170 lbs.	

entering the cylinder during both tests. In case of the competitive or lighter oil, the discharge water has increased 40° in temperature. In case of the heavier Ursa Oil, there is an increase of only 24°. There is a difference of 16°, or 14.5% lost heat being carried away by the cooling water from the cylinders. This amount of heat can be directly transposed into its horsepower equivalent.

The results of the entire test are very logical, showing that oil of our make of a very heavy body can be used to great advantage as far as consumption is concerned. It naturally follows that not so much of a heavy oil is necessary to do certain work as would be required of a light oil, and that even competing with a cheaper oil, the Ursa Oil shows great cost reductions with high power efficiency.

Owing to the peculiar efficiency of our Texaco Oils, the fact of using a heavier oil in order to secure and maintain low costs does not have any detrimental effect upon the power, as represented by the temperatures due to friction, or as represented by the temperature of the discharged cooling water. On the contrary, our heavier oil, in the case of the bearings, shows less frictional temperature, because the internal friction of this oil is less than the internal friction of the lighter competitive oil, and the body of the oil is great enough to reduce the friction between the piston rings and cylinder walls inside of the gas engine, which has a direct effect upon the temperature of the discharged water. It is well known that motors or gas engines, which are hard to lubricate, show high temperatures in their cooling systems. One of the best indications of trouble with internal lubrica-

tion in a gas engine is the boiling over of the cooling water. As soon as a good lubricant is placed in the cylinder, the water shows the effect by discharging at a lower temperature. One of the indications of a poor lubricant in a bearing is the increased temperature of that bearing. As soon as the better lubricant is placed upon the hot bearing, the temperature decreases. These indications are absolute.

TEXACO URSA OIL

A GENERAL Electric Company's Horizontal Low Pressure Turbine in an Eastern shop, working on exhaust steam from a set of Westinghouse Crank Case Engines, was operated for over a year on an unusually good competitive oil, this oil having a viscosity of 480″ at 100° F. on a Saybolt Viscosimeter. To those who are fully informed in regard to the viscosities of turbine oil, it will be apparent that this competitive oil was unusually heavy for use in a turbine. This particular turbine, however, was being operated on a high oil pressure system to the governor gear case and bearings; that is, it was considered that the higher the pressure at these two points, the greater the operating margin of safety would be. With the same pump and relief valve arrangement, the gear case and bearing pressure would naturally increase with the increase in body or viscosity of the oil; that is, the heavier the oil used the greater the pressure that could be maintained in the system. It was thought that the use of a very much heavier bodied oil would naturally increase the temperature of the bearings (as the bearing temperature is closely related to the body or viscosity of an oil). This was not desired, and this one point of bearing temperature limited the body or viscosity of the oil.

Very heavy bodied lubricants, when made of a paraffine oil, must of necessity contain a considerable proportion of cylinder stock in order to get the body. This cylinder stock mixture would be apt to cause trouble in a closed circulating system if any moisture should come in contact with the oil. It has been found, as a result of a great number of tests, that oils made up with a cylinder oil mixture will throw out very objectionable deposits after working for some considerable time, especially when water is brought in contact with the circulating oil.

This particular turbine had been used for trying out quite a number of competitive oils from time to time. All of the oils, however, failed to maintain the gear case pressure, which the makers had specified and which the plant operators considered necessary, in order that the machine could be operated without damage.

In trying our Ursa Oil on this turbine, we had in mind that putting in a heavy bodied oil would give much greater pressure in the gear case and in the bearings; and, at the same time, on account of the peculiar nature of our oils, we would not have any greater bearing temperature than with the former lighter bodied oil. Very careful tests of temperature were made with the competitive oil, readings being taken every hour from nine to four o'clock. After this test the oil was removed and Texaco Ursa Oil placed in the turbine and allowed to run for some time, after which the same observations were made. The average results of the entire test are as follows:

	Competitive Oil	Texaco Ursa Oil	Difference
Average bearing temperature . .	123.7° F.	121.5° F.	2.2° F. or 1.8%
CIRCULATING OIL			
Intake	128 ° F.	125.3° F.	
Discharge	132 ° F.	129 ° F.	
Difference	4 ° F.	3.7° F.	
PRESSURE			
Gear Case	117 lbs.	150 lbs.	33 lbs.
Bearing	13.2 lbs.	18.7 lbs.	5.5 lbs.
LOAD AVERAGE			
Amperes (Load)	1925	1887	
Cooling Water	56 ° F.	56 ° F.	
Average Room Temperature . .	95.4° F.	85.7° F.	9.7° F.
Viscosity of Oil at 100°	480″	750″	

The room temperature was 9.7° less during the test of the Ursa Oil. The bearing temperature was 2.2° less. This would make the actual frictional heat shown on the bearings greater during the use of Ursa Oil. During the test of both oils, however, the room was 90° at the first of one test and at the end of the other. This difference in temperature did not seem to greatly affect the bearing temperatures; in fact, in this particular test, there seems to be little influence on the temperature of the bearings due to the variation of temperature of the room. The load, as shown by amperes, varied from hour to hour; the variations did not affect the other readings, nor was the power in any way affected by the change of the other conditions.

The main point, which can be taken as showing the actual frictional effect of the two lubricants, would be the difference in temperature between the oil going on to the bearing and the oil coming out of the bearing. This directly indicates the amount of lost energy under the two conditions of lubrication, and the temperature with amount and flow of the circulating oil can be transposed into lost horse power. The average rise or increase in temperature between the ingoing and outgoing competitive oil was 4° F., and with the Ursa Oil 3.7° F., a difference of .3° F. or 7.5%. This reduction in heat loss, while small, is due entirely to the greater lubricating power of the Texaco Ursa Oil. This oil, as will be seen by the table, is very much heavier in viscosity than the competitive oil, yet it acts quite contrary to what has always been supposed would be the rule governing the effect of viscosity upon lubrication.

Heretofore, in working with oils made of a paraffine base, these oils have always acted in accordance with

the general rule that was the result of a great number of testing-machine experiments, which were made in various technical laboratories. The rule is, practically, that increasing the viscosity of an oil will, within limits, increase the frictional heat shown on a bearing. Frictional heat is always an indication of lost power. This rule means, that with machinery in operation, increasing the viscosity of the lubricating oil will show within certain limits that more power will have to be consumed. Inverting the rule would mean that reducing the viscosity of the oil would show a reduction in power; likewise, a reduction in that best indication of lost power, the frictional heat of the bearing. This rule is well established, and is always considered by all oil engineers in making their general recommendations.

It seems, however, that this rule only applies to oils made from paraffine base crudes, and when oils made from these crudes are compared to oils made from the crudes from which Texaco Oils are produced, the results do not follow this general law.

We have found in quite a number of tests that, contrary to the general practice, we have been able to secure lower frictional temperatures on bearings by putting in very much heavier oils of our make, than the oils that were previously lubricating the bearings under observation.

The fact that we can secure a reduction in temperature by using heavier bodied oils was surprising, and was a matter that required very careful investigation before being made public. We have found in many tests that, within very wide limits, it follows that our Texaco Lubricating Oils, made up of low gravity crude, will effect a reduction in temperature and consequently reduction in lost power when used against high gravity oils of very much less viscosity. The test on this turbine proves this quite clearly. The fact that the gear case pressure was increased 33 lbs. and the pressure on the bearing 5.5 lbs. shows quite clearly that this Texaco Ursa Oil was a heavier bodied oil. This is shown by the viscosity of the two oils, one being 480″ and the other 750″ at the same temperature on the same instrument. The fact that there was a less amount of heat being carried away from the bearings and that the actual average bearing temperature was 2.2° F. less, shows conclusively that the oil was furnishing better lubrication; that is, the fluid friction of the oil, which is practically the only thing to be considered in this case, was less with the Texaco Ursa Oil than with the competitive lighter bodied oil.

TEXACO ON THE RAILROADS

IT is well known that the railroads of the United States are going deeply into the subject of efficiency. They have carefully examined and estimated their running cost per thousand miles, and by continual watching, they have, and are further, materially cutting down the running expense of all their trains. This change, for the better, does not simply entail changes in equipment, such as new devices of safety, but deals directly with the amount of oil, coal, fuel oil, etc., consumed per thousand miles.

The manner of dealing with the consumption of lubricating oil is a particularly good example of their methods. Each crew has a certain amount of oil portioned out to it for each run. This is sufficient as worked out by engineers, who have made a conscientious study of the proposition. Naturally, an engineer is entitled to draw more oil if needed. An extra allowance charged against the crew is an indication that there is something wrong, and a visiting engineer by simply looking over the sheet in the Oil House can tell where his services are needed. His work by this plan is greatly extended.

It requires an oil, whether fuel or lubricating, of high quality to insure the continuance of running efficiency, based on cost per thousand miles.

In numerous tests against all kinds of competitors, Texaco Oils have shown themselves to possess an extra amount of quality, secured by special care in refining, which operates to secure that added degree of efficiency which makes the difference between a merely good oil, and the best oil for the purpose.

There is stronger testimony than even the results of such tests. This is the evidence of the Sales Sheets, the ultimate and final arbiter of satisfaction and worth. In this connection, we take pardonable pride in announcing that two of the largest railroads in this country have just signed a contract, and as both of these are renewals, one for five years, the other for three, the success of the oils is not due to any arts of salesmanship, but is due solely to the satisfaction shown in results. As these railroads had the opportunity of thoroughly testing out our oils,—not under special conditions and not for a few weeks, but in actual operation and for a period of more than one year, and considering the fact that they had the results of general inspections and the figures of their cost sheets right at their fingers' ends, there can be but little doubt that these people had complete information concerning Texaco Oils, and that their reorders are based on thorough knowledge and are made for the soundest of reasons.

This is but an example of how one order of Texaco Lubricants is followed by continued reorders. It will pay you to get into communication with us concerning your lubricating requirements. Surely you want the benefits of Texaco Quality, and Texaco Quality holds customers through its ability to satisfy.

Our lubricating experts are always prepared, and more than willing, to discuss your problems with you, and to demonstrate to you the possibility of increasing the efficiency of your outfit through Texaco Lubricants—"the kind that cost less, because they give more."